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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

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June 1970

U.S. Training and
Employment Service
Technical Report
S-330 R

Development of USTES

APTITUDE TEST
BATTERY FOR

CHEMICAL OPERATOR

(chem.) III
559.782

U.S DEPARTMENT OF LABOR
Manpower Administration

ED 069775

Technical Report on Development of USTES Aptitude Test Battery

For . . .

Chemical Operator (chem.) III 559.782

S-330R

(Developed in Cooperation with the
New Jersey State Employment Service)

U.S. Department of Labor
Manpower Administration

June 1970

FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existance for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

GATB Study #2535

Development of USTES Aptitude Test Battery

For

Chemical Operator (chem.) III 559.782-046

S -330 R

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Chemical Operator (chem.) III 559-782-046. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
N - Numerical Aptitude	80
S - Spatial Aptitude	100
P - Form Perception	70

RESEARCH SUMMARY

Sample: 50 workers employed as chemical operators in New Jersey.

This study was conducted prior to the requirement of providing minority group information. Therefore, minority group status is unknown.

Criterion: Supervisory ratings

Design: Concurrent (test and criterion data were collected at approximately the same time).

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, aptitude-criterion correlations and selective efficiencies.

Concurrent Validity: Phi Coefficient = .38 ($P/2 < .005$)

Effectiveness of Norms:

Only 72% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the above norms, 87% would have been good workers. Twenty-eight percent of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the above norms, only 13% would have been poor workers. The effectiveness of the norms is

shown graphically in Table 1.

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Workers	72%	87%
Poor Workers	28%	13%

SAMPLE DESCRIPTION

Size: N = 50

Occupational Status: Employed workers.

Work Setting: Workers were employed by Toms River Chemical Company and E. I. duPont de Nemours in New Jersey.

Employer Selection Requirements:

Education: None required.

Previous Experience: None required.

Tests: None used.

Other: Personal interview.

Principal Activities: The job duties for each worker are comparable to those shown in the job description in the Appendix.

Minimum Experience: All workers in the final sample had at least six months job experience. (Workers who had 240 or more months experience were eliminated in order to decrease the correlation between the criterion and length of experience.)

TABLE 2

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education, and Experience

N=50

	Mean	SD	Range	r
Age (years)	38.9	7.8	24-52	-.001
Education (years)	10.7	1.6	7-13	-.011
Experience (months)	53.0	57.4	6-228	-.307*

*Significant at the .05 level

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B were administered during the period February 1962 to October 1964.

CRITERION

The criterion data consisted of supervisory ratings of job proficiency made at approximately the same time as the tests were administered with a time interval of two weeks between the two ratings. The immediate supervisor rated each worker.

Rating Scale Form SP-21 "Descriptive Rating Scale" was used. The scale (see Appendix) consists of nine items covering different aspects of job performance. Each item has five alternative responses corresponding to different degrees of job proficiency. The criterion was corrected for experience. Calculations for the correction factor were made separately for each set of ratings.

Reliability: A reliability coefficient of .84 was obtained between the initial ratings and the re-ratings, indicating a significant relationship. The final criterion score consists of the combined scores of the two ratings.

Criterion Distribution:

Possible Range:	18-90
Actual Range:	29-82
Mean:	60.8
Standard Deviation	12.2

Criterion Dichotomy: The criterion distribution was dichotomized into low and high groups by placing 28% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high criterion group were designated as "good workers" and those in the low group as "poor workers." The criterion critical score is 55.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitudes Q and M which do not have high correlations with the criterion, were considered for inclusion in the norms because the qualitative analysis indicated that the aptitudes might be important for the job duties and the sample had a relatively high mean score on aptitude M and a rather low standard deviation for aptitude Q. Aptitude N was considered for inclusion in the trial norms because Aptitude G which should have been considered was eliminated from consideration in this reanalysis to minimize the verbal requirements of the battery. In the composition of Aptitude G, arithmetic reasoning has the highest factor loading.

TABLE 3

Qualitative Analysis
(Based on the job analysis, the aptitudes indicated appear to be important to the work performance)

Aptitude	Rationale
G - General Learning Ability	Required to read, understand and follow instructions in all phases of processing and to plan the sequence of the processing.
N - Numerical Aptitude	Required to calculate quantities of materials and to make accurate numerical interpretation in units of time and temperature to be recorded.
S - Spatial Aptitude	Required to understand the relationship between the structure of the processing equipment and the chemical operations.
Q - Clerical Perception	Required to make out requisitions for materials, to record the details of processing and to keep an accurate log of each batch of dye stuffs.
M - Manual Dexterity	Required to handle equipment such as pumps, condensers, evaporators, etc., to prepare and produce batches of dye stuffs.

TABLE 4

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB

N = 50

Aptitudes	Mean	SD	Range	r
G - General Learning Ability	104.8	13.1	76-136	.195
V - Verbal Aptitude	102.7	13.0	77-144	.179
N - Numerical Aptitude	100.6	14.9	68-135	.269
S - Spatial Aptitude	105.3	17.4	67-140	.286*
P - Form Perception	94.6	13.2	51-115	.058
Q - Clerical Perception	98.2	12.0	62-133	.075
K - Motor Coordination	104.0	13.9	66-130	.186
F - Finger Dexterity	93.5	17.3	55-131	.128
M - Manual Dexterity	105.6	19.6	71-149	.071

*Significant at the .05 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data: Important	X		X	X		X			X
Irrelevant									
Relatively High Mean	X			X			X		X
Relatively Low Standard Dev.	X	X			X	X			
Significant Correlation with Criterion				X					
Aptitudes to be Considered for Trial Norms	G		N	S		Q			M

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of the degree to which trial norms consisting of various combinations of aptitudes N, S, Q and M at trial cutting scores were able to differentiate between the 72% of the sample considered to be good workers and the 28% of the sample considered to be poor workers. Trial cutting scores at five-point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For four-aptitude trial norms, cutting scores of slightly less than one standard deviation below the mean will eliminate about one-third of the sample; for two-aptitude trial norms, minimum cutting scores of slightly more than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. Norms of N-80, S-100, and P-70 provided optimum differentiation for the occupation of **Chemical Operator** III (chem.) 559.782-046. The validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .38 (statistically significant at the .005 level).

TABLE 6

Concurrent Validity of Test Norms N-80, S-100, and P-70

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	9	27	36
Poor Workers	10	4	14
Total	19	31	50

Phi Coefficient (ϕ) = .38 Chi Square (X^2y) = 7.4
Significance Level = P/2 $<$.005

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study did not meet the requirements for incorporating the occupation studied into an OAP. However, the occupation was placed in OAP-34 which is shown in the 1970 edition of the Manual for the General Aptitude Test Battery as a result of qualitative analysis.

SP-21

A-P-P-E-N-D-I-X

DESCRIPTIVE RATING SCALE
(For Aptitude Test Development Studies)

Score____

RATING SCALE FOR _____
D. O. T. Title and Code

Directions: Please read Form SP-20, "Suggestions to Raters", and then fill in the items listed below. In making your ratings, only one box should be checked for each question.

Name of Worker (print) _____
(Last) (First)

Sex: Male_____ Female_____

Company Job Title: _____

How often do you see this worker in a work situation?

- ☐ See him at work all the time.
- ☐ See him at work several times a day.
- ☐ See him at work several times a week.
- ☐ Seldom see him in work situation.

How long have you worked with him?

- ☐ Under one month.
- ☐ One to two months.
- ☐ Three to five months.
- ☐ Six months or more.

A. How much work can he get done? (Worker's ability to make efficient use of his time and to work at high speed.)

☐ 1. Capable of very low work output. Can perform only at an unsatisfactory pace.

☐ 2. Capable of low work output. Can perform at a slow pace.

☐ 3. Capable of fair work output. Can perform at an acceptable but not a fast pace.

☐ 4. Capable of high work output. Can perform at a fast pace.

☐ 5. Capable of very high work output. Can perform at an unusually fast pace.

B. How good is the quality of his work? (Worker's ability to do high-grade work which meets quality standards.)

☐ 1. Performance is inferior and almost never meets minimum quality standards.

☐ 2. The grade of his work could stand improvement. Performance is usually acceptable but somewhat inferior in quality.

☐ 3. Performance is acceptable but usually not superior in quality.

☐ 4. Performance is usually superior in quality.

☐ 5. Performance is almost always of the highest quality.

C. How accurate is he in his work? (Worker's ability to avoid making mistakes.)

☐ 1. Makes very many mistakes. Work needs constant checking.

☐ 2. Makes frequent mistakes. Work needs more checking than is desirable.

☐ 3. Makes mistakes occasionally. Work needs only normal checking.

☐ 4. Makes few mistakes. Work seldom needs checking.

☐ 5. Rarely makes a mistake. Work almost never needs checking.

D. How much does he know about his job? (Worker's understanding of the principles, equipment, materials and methods that have to do directly or indirectly with his work.)

☐ 1. Has very limited knowledge. Does not know enough to do his job adequately.

☐ 2. Has little knowledge. Knows enough to "get by."

☐ 3. Has moderate amount of knowledge. Knows enough to do fair work.

☐ 4. Has broad knowledge. Knows enough to do good work.

☐ 5. Has complete knowledge. Knows his job thoroughly.

E. How much aptitude or facility does he have for this kind of work? (Worker's adeptness or knack for performing his job easily and well.)

☐ 1. Has great difficulty doing his job. Not at all suited to this kind of work.

☐ 2. Usually has some difficulty doing his job. Not too well suited to this kind of work.

☐ 3. Does his job without too much difficulty. Fairly well suited to this kind of work.

☐ 4. Usually does his job without difficulty. Well suited to this kind of work.

☐ 5. Does his job with great ease. Exceptionally well suited for this kind of work.

F. How large a variety of job duties can he perform efficiently? (Worker's ability to handle several different operations in his work.)

☐ 1. Cannot perform different operations adequately.

☐ 2. Can perform a limited number of different operations efficiently.

☐ 3. Can perform several different operations with reasonable efficiency.

☐ 4. Can perform many different operations efficiently.

☐ 5. Can perform an unusually large variety of different operations efficiently.

G. How resourceful is he when something different comes up or something out of the ordinary occurs? (Worker's ability to apply what he already knows to a new situation.)

☐ 1. Almost never is able to figure out what to do. Needs help on even minor problems.

☐ 2. Often has difficulty handling new situations. Needs help on all but simple problems.

☐ 3. Sometimes knows what to do, sometimes doesn't. Can deal with problems that are not too complex.

☐ 4. Usually able to handle new situations. Needs help on only complex problems.

☐ 5. Practically always figures out what to do himself. Rarely needs help, even on complex problems.

H. How many practical suggestions does he make for doing things in better ways? (Worker's ability to improve work methods.)

☐ 1. Sticks strictly with the routine. Contributes nothing in the way of practical suggestions.

☐ 2. Slow to see new ways to improve methods. Contributes few practical suggestions.

☐ 3. Neither quick nor slow to see new ways to improve methods. Contributes some practical suggestions.

☐ 4. Quick to see new ways to improve methods. Contributes more than his share of practical suggestions.

☐ 5. Extremely alert to see new ways to improve methods. Contributes an unusually large number of practical suggestions.

I. Considering all the factors already rated, and <u>only</u> these factors, how acceptable is his work? (Worker's "all-around" ability to do his job.)

☐ 1. Would be better off without him. Performance usually not acceptable.

☐ 2. Of limited value to the organization. Performance somewhat inferior.

☐ 3. A fairly proficient worker. Performance generally acceptable.

☐ 4. A valuable worker. Performance usually superior.

☐ 5. An unusually competent worker. Performance almost always top notch.

FACT SHEET

Job Title: Chemical Operator III (chem.) 559.782-046

Job Summary: Operates autoclaves, kettles, mixers and similar equipment which convert raw materials into dyes, and processes intermediate chemicals into dyes through a series of diverse chemical reactions. Performs supplementary duties, such as sampling, minor testing, and keeping operating records.

Work Performed: Makes preparations to produce a batch of dye stuffs or intermediate chemicals in accordance with instructions issued by laboratory chemists. Sends requistion to stock room to arrange to have the specified quantity of raw materials brought to the processing equipment for charging at the proper time. Orders the measuring tanks to be filled with liquid, such as ammonia or sulphuric acid to be used in the batch.

Starts and follows through the processing of the batch until it is completed. Cleans equipment with water hose and dumps specified materials into kettle or autoclave and opens valves to admit the liquid. When the equipment is charged, the manhole cover is put into place over the opening and secured with wingnuts. Opens valves to admit steam, hot water, or hot oil into the heating jacket of the equipment, and adjusts valves to maintain specified temperature. Turns on switch to activate mixer or agitator and may dump ice into the mix to cool it off rapidly. May admit nitrogen gas into the vessel to create an inert, non-explosive atmosphere. May adjust draft regulator by turning a handle to permit excess gases or steam to pass off while losing as little of the product as possible. Follows chemist's instructions closely in all phases of processing, paying attention to time interval before adding other material, changing temperature and changing mixing speed.

For some colors of dyes it is necessary to prepare the intermediate chemicals in separate batches. Each of these batches will be started at different times, but in such a manner that all will be ready to be combined simultaneously. The operator then pumps each of the batches into one vessel, or drops the blowleg to the bottom of the batch and applies

compressed air to the top in order to force the material through the blowleg and pipe into the final processing equipment. Operates pumps, condensers, and evaporators to recover excess volatile solvents. Watches thermometer and controls temperature in different parts of the system by operating valves to admit steam or hot water so that liquids, each with its own boiling point, will be collected in its own part of the system and pumped back to its own storage tank.

Performs simple tests such as dipping litmus paper into a sample of the mix to determine if its reaction is acid or alkaline. At the stage of processing indicated in the instructions, removes a sample of the batch with a long handled dipper, puts it in a bottle and sends it to the laboratory where it will be analyzed to determine that the processing is progressing properly. Keeps a written log of each batch, recording all pertinent details of the process, including time intervals, heat, pressure, mixing speed, color and other features.

Effectiveness of Norms: Only 72% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the S-330R norms, 87% would have been good workers. 28% of the nontest-selected workers used for this study were poor workers; if the workers had been test selected with the S-330-R norms, only 13% would have been poor workers.

Applicability of S-330 R Norms: The aptitude test battery is applicable to jobs which include a majority of duties described above.

GPO 898.793

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